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The benefits of the subsidized housing programs: public housing, rent certificates, and the housing voucher program

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The benefits of the subsidized housing programs:

Public housing, rent certificates,
and the housing voucher program

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by

Cho-Min Lin

A Thesis Submitted to the
Graduate Faculty in Partial Fulfillment of the
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Signatures have been redacted for privacy

Iowa State University
Ames, Iowa
1989

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1. INTRODUCTION

1.1 General Background

From 1937, many types of subsidy programs in housing have been implemented or proposed. A common purpose is to help low-income families afford better housing. In 1937 the Housing Act of 1937 was passed, which created the U.S. Housing Authority (Elizabeth Huttman and Willem van Vliet, 1988). The public housing program was introduced in this act. The program's objectives were to help many low-income families live in better housing during the Depression, reduce unemployment and eliminate slums. However, in the 1970s, some economists felt these production-oriented programs entailed large costs serving only a fraction of the poor, and that the costs exceeded benefits. So, the Housing and Community Development Act of 1974 was passed in the Nixon Administration. This Act favored demand-oriented programs in which subsidies were paid to participants. It allowed households to find adequate dwelling units on the private market¹. For subsidized housing programs, this is another landmark. The Act of 1974 shifted the subsidies to participants from contractors and landlords, and the Section 8 housing program came under this act. Furthermore, in 1983 Congress passed the Housing and Urban-Rural Recovery Act in which the

¹Adequate dwelling units are to be safe, sanitary, and decent housing units.

housing voucher program was initiated. The relevant statement as follows:

The tenants received direct housing subsidies in the form of housing vouchers. These represented a modification of the Section 8 Existing Housing program and housing allowances.

Among these housing subsidy programs², public housing is the traditional program in which ownership of dwelling units belongs to the government. In contrast, the Section 8 Existing Housing and housing voucher programs utilize privately owned housing units.

1.2 Statement of the Purpose and Framework

In this thesis, tenant benefits are compared for the three programs mentioned above. Marshallian Consumer's Surplus and Hicksian Equivalent Variation (Hicksian Consumer's Surplus) are utilized to estimate tenant benefits. In addition, benefits are regressed on monthly income, before program rent, the age of household head, family size, race and the sex of household head to empirically test these concepts.

The organization of the thesis is as follows: The first chapter presents a general background for subsidized housing programs and defines some terms. The following chapter presents a program overview, and previous studies will be reviewed in the third chapter. The theoretical framework is presented in the fourth chapter. The fifth chapter presents the empirical findings and a final chapter summarizes the conclusions

²Elizabeth Huttman and Willem van Vliet (1988) included about nine housing subsidy programs: public housing, Section 221, Section 312, Section 235, Section 236, Section 8 new-construction, Section 8 substantial & moderate rehabilitation, Section 8 Existing Housing, and Housing vouchers.

to be derived from this thesis.

1.3 Program Definitions

Some of the specific terms used in this thesis are the following:

- **HUD** The U.S. Department of Housing and Urban Development.
- **Contract Rent** The rent paid to the owner of the dwelling unit which is usually shared by the tenant and HUD.
- **Gross Rent** The sum of the contract rent and utility allowance. If there is no utility allowance, contract rent equals gross rent.
- **Fair Market Rent** The rent including utilities (except telephone), ranges and refrigerators, necessary to obtain privately owned, existing, decent, safe and sanitary rental housing of a modest nature with suitable amenities. Separate fair market rents are established for dwelling units of varying sizes (number of bedrooms) and types.
- **Low-Income Family** A family whose income does not exceed 80 percent of the median income for the area as determined by HUD with adjustments for smaller or larger families.
- **Very low-Income family** A family whose income does not exceed 50 percent of the median income for the area as determined by HUD with adjustments for smaller or larger families.

- **Eligible Family** A family which qualifies as a low-income or very low-income family.
- **Standard Housing** Housing that is in a decent, safe, and sanitary condition.
- **Public Housing Agency (PHA)** Any state, county, municipality or other governmental entity or public body which is authorized to engage in or assist in the development or operation of housing for low-income families.
- **Owner** Any person or entity having the legal right to lease housing.
- **Tenant Rent** Formerly called net family contribution. The amount payable monthly by the family as rent to the owner. Where all utilities (except telephone) and other essential housing services are supplied by the owner, tenant rent equals total tenant payment. Otherwise the tenant rent equals total tenant payment less than utility allowance.
- **Total tenant payment (TTP)** The total amount the HUD rent formula required the tenant to pay toward the gross rent.
- **Adjusted Income** Gross income minus dependent deduction, allowable child care expense, allowable handicap assistance expense, allowable medical expense, and elderly household deduction.
- **Housing Assistance Payment** The monthly payment by the PHA to an owner on behalf of a family participating in the housing voucher program. Generally, the amount of the housing assistance payment is determined by sub-

tracting 30 percent of a family's monthly adjusted income from the payment standard or gross rent that applies to the family.

- **ACC** A written agreement between HUD and a contract administrator to provide annual contributions to cover housing assistance payments and other expenses pursuant to the Act.
- **Payment Standard** The payment standard is established as the fair market rent in effect when the ACC is executed for the first increment of funding.

2. PROGRAM OVERVIEW

2.1 Public Housing Program

This is the oldest housing subsidy program in which units are owned and controlled by the national or local government (Elizabeth Huttman and Willem van Vliet, 1988). Eligible families whose income is below a specific standard¹ have the right to enter this program. The participant usually is charged 30 percent of his own adjusted income as the project rent. In this program, tenants apply for units vacant in the project; in other words, households have little choice as to the type and location of housing units. From economics this is termed an in-kind transfer program (i.e., non-cash transfer program). After 1965, the public housing program started to decline due to increasing cost and inefficiency. According to HUD statistics in 1986, public housing declined in the amount of housing units provided compared to the other subsidized housing programs (Elizabeth Huttman and Willem van Vliet, 1988). The subsidized housing programs shifted toward more effective programs. As a result of the disadvantage of public housing, the direct cash payment programs were proposed in lieu of the traditional housing program.

¹Usually, the household whose income is below 80 percent of the median income could be a eligible household. Prescott (1974) utilized the private-equivalent rent to establish income limits. If the participant's income was above the limit he could be excluded from this program.

2.2 Rent Certificates

As mentioned above, the public housing program was inefficiently operated. Milton Friedman and other conservative economists have suggested that direct cash grants to the poor are better than providing specific goods or services and the free-market mechanism is substituted for housing programs so that the subsidy to the poor is more efficient. In fact, the Section 8 Existing Housing program also could be called **rent certificates** in which recipients are allowed to choose any dwelling unit which meets the project requirements in the private market. However, the recipients are still required to consume the face value of the certificate; that is, they cannot consume more. The rent subsidy to eligible families is the difference between 30 percent of the household's adjusted income² and the fair market rent. In addition, the initial gross rent cannot be larger than the fair market rent.

Based on this discussion the rent certificate is similar to a cash allowance program. From viewpoint of economic theory we can call this program a kind of constrained cash transfer.

2.3 Housing Voucher Program

The housing voucher program is a **pure cash allowance** compared to the rent certificate. Though tenants with rent certificates have more freedom in housing consumption, it is still closely tied to the specific unit through a 15-year contract signed with the landlord (Module V); moreover, the landlord should not charge less than the

²The total tenant payment is the greater of 30 percent of adjusted monthly income and 10 percent of gross monthly income.

fair market rent and the tenants are also not encouraged to find a cheaper dwelling unit. In view of the fact that consumption was constrained, the Reagan administration proposed a housing voucher program in 1982³, in which the tenants were authorized to consume more or less housing than the standard; if they consume less, then they can receive a credit; on the other hand, if they consume more they pay the additional amount themselves. The tenants are not subject to consume a standard dwelling unit established by government and they are free to find their own apartments and negotiate with landlords⁴.

The subsidy was mainly based on the difference between 30 percent of the family's adjusted income and the applicable payment standard. The gross rent could be allowed to be the same as the payment standard. In addition, the amount of rent exceeding the payment standard is paid by the household. The housing voucher program's tenants obtain more freedom to choose suitable housing units, not like public housing in which units are tied to specific location and housing types. A table that compares Section 8 Existing program and the voucher program is presented in Table 2.1 (Module V).

³The program is not new, having been proposed 40 years ago. It was rejected in the Housing Act of 1937 (Friedman and Weinberg, 1982).

⁴In Section 8 Existing Housing program, the government reserves the right to negotiate with the landlord.

Table 2.1: Rent certificate vs. housing voucher

| Program Component | Rent Certificate | Housing Voucher |
|-----------------------|---|---|
| Subsidy level | Subsidy amount equals the difference between 30 % of the family's adjusted income and gross rent of the unit. | Subsidy amount is usually the difference between 30 % of the family's adjusted income and the applicable payment standard. |
| Total Tenant Payment | The total tenant payment is the higher of 30 % of adjusted monthly income, 10 % of gross monthly income, or the welfare rent in as-paid states. | The minimum payment is 10 % of gross monthly income. There is no maximum total tenant payment. |
| Housing Quality | The housing quality must meet decent, sanitary, safe requirements. | Identical to Section 8 Housing program. |
| Shopping Incentive | Initial gross rent cannot exceed the applicable fair market rent. | If family rent a unit below the payment standard, the family could keep the credit; the family also can shop more housing services (i.e., rent exceed payment standard). They must pay the additional rental by themselves. |
| Certificate Ownership | Certificate stays with recipients. | Identical to Section 8 Existing Housing program. |

Table 2.1 (continued)

| Program Component | Rent Certificate | Housing Voucher |
|------------------------|---|--|
| PHA/owner Relationship | The PHA and owner sign a housing assistance payments contract or housing voucher contract and a housing assistance payment is made to the owner on behalf of the tenants. | Identical to Section 8 Existing Housing program. |
| Contract Period | The contract period between HUD and local agency is 15 years. | The contract period between HUD and local agency is 5 years. |
| Subsidy Charged | Allowed the subsidy amount to increase annually. | Allowed the subsidy amount to increase only twice over a five years. |

3. LITERATURE REVIEW

3.1 Introduction

Numerous studies presented estimates of the benefits accruing to households from subsidized housing programs and have usually used Marshallian Consumer's Surplus and the Hicksian Equivalent Variation (i.e., Hicksian Consumer's Surplus).

The purpose of this chapter is to review some studies related to these two methods. Economists called the public housing an in-kind transfer such as food-stamps, while rent certificates and housing vouchers are viewed as a kind of income transfer. At the same time, economists have emphasized economic efficiency in the subsidized housing programs. Furthermore, by comparing the magnitudes of proposed programs they have provided suggestions to the government as to the best way to provide **truly needy** households with better housing.

3.2 The Main Review

The following section reviews some papers on the orientation of the net benefits estimated by approaches such as Marshallian and Hicksian surplus. Specific utility functions such as the Cobb-Douglas and Stone-Geary will also be discussed.

In this thesis, we will employ both Marshallian Consumer's Surplus and Hicksian

Equivalent Variation with the latter discussed in the next chapter. These papers are as follows: Olsen and Prescott (1969), Olsen (1972), Kraft and Kraft (1979), Yu and Li (1985), Sumka and Stegman (1978), Mayo (1986), Bish (1969), and Struyk (1988). Most of the other studies focused on the Hicksian measure.

3.2.1 The Marshallian measure

Olsen and Prescott (1969) derived formulas to estimate net tenant benefits and compared their estimates and the best measure for a sample of individual tenant data from the Federal public housing program. They also estimated the percentage change in the consumption of housing services and nonhousing goods experienced by public housing tenants. Regression equations measured the variation of tenant benefits with family size and income.

In their paper formulas were developed to measure the magnitude of net tenant benefits under Marshallian demand curve assumption. The **best** measure of net benefits for all tenants is

$$B_t = \sum_{i=1}^n [(P_m Q_m)_i - (P_c Q_c)_i + (P_m Q_m)_i (\log(P_m Q_c)_i - \log(P_m Q_m)_i)]$$

where $P_m Q_m$ is before-program rent, $P_c Q_c$ is tenant's payment, $P_m Q_c$ is private-equivalent rent, and n is family size. This measure was derived from $B_t = P_m Q_m - P_c Q_c + \int_{Q_m}^{Q_c} D$ under the assumption that the demand curve is $P = \frac{P_m Q_m}{Q}$. Prescott used the difference between the market rent of a public housing unit and the rent paid by its tenant, and Olsen's measure was equivalent to using a consumer's surplus measure of tenant benefits with an assumed price elasticity equal to -1.0. The Prescott measure always overestimates total net benefits and the Olsen may give either larger

or smaller estimates of tenant benefits than the true measure. They concluded that mean tenant benefits in public housing was about \$300 in 1960, and tenants in public housing increase the real income by 10 percent, and consume 18 percent more housing service than they would have consumed in the absence of a housing subsidy. In addition, they also regressed benefits on monthly income and family size obtaining a negative relationship with family income and positive relationship with family size.

Olsen (1972) employed Marshall's consumer surplus to illustrate net tenant benefits to participants. In his study he presented the probability of consuming a greater quantity of nonhousing goods and less housing service as a result of rent control. He collected data which based on the 1968 New York City Housing and Vacancy Survey which included about 35,000 individual housing units and their households. In addition, he regressed before-project rent on annual income of the household, age of head of household, family size, race, sex in sample with 5,919 observations. From this regression equation, he found the value of the predictor of before-program rent. He also investigated consumption changes by estimating how much more or less housing and nonhousing goods are consumed under rent-control than in the absence of this program. In his empirical findings, it is surprising that the 4.4 percent less housing service and 9.9 percent more nonhousing goods were consumed under rent control. Olsen mentioned the following:

If we give up this assumption that all of them live in the same quality housing, that is, consuming the same housing service what about this change? Some economists suggest that most tenants of controlled apartments would prefer less spacious quarters in better condition. However,

some people think they would prefer low-quality larger apartments.

He also used a hedonic index method to find the market rent in which he regressed market rent on the number of bedrooms, number of other rooms, condition of unit, number of stories, presence of elevator, location, and the age of dwelling.

Finally he tried to find a relationship between tenant benefits and household characteristics such as mean real annual income, family size, age, race and sex. Benefits vary less significantly with race and sex of the head of the household, richer families receive smaller benefits from rent control than poorer families, and there exists a positive relationship between benefits and age of household head and family size. He also showed us that black tenants receive larger benefits than white tenants. The mean net benefit is \$213, mean income of families is \$6,229, and real income increased by 3.4 percent in New York City in 1968.

Kraft and Kraft (1979) also employed the Marshallian demand curve to estimate the net benefits received by participants. Except for the market rent of subsidized unit, other variables could be observed. They adopted a hedonic index that is constructed to predict the market rent of subsidized units. They also regressed the market rent of subsidized unit on family characteristics.

The empirical data covered 335 families living in public housing in Boston, Pittsburgh, St.Louis, San Francisco, and Washington D.C. in 1971. The results implied that public housing tenants in this sample experienced a 59 percent increase in housing consumption and a 5 percent increase in purchases of nonhousing goods compared to what they would have consumed in the absence of the program. In addition, the net tenant benefits of monthly subsidy is \$52 and net benefits as percentage of in-

come is 22 percent. They regressed net benefits on family income, family size, race, sex, and age of head of household. There exists a negative relationship between net benefits and age of head of household. From this regression equation vertical equity with respect to income is implied due to the benefits decline as income increases; that is, the households who are at a higher income level experience lower benefits from the subsidized housing program.

Yu and Li (1985) estimated tenant benefits in Hong Kong's public housing program based on the Marshallian measure. The results indicate that this program in Hong Kong has affected the household's consumption patterns, and the welfare loss is not so relatively high. In their study, they established net tenant benefits by $P_a Q_a - P_s Q_s + \int_{Q_s}^{Q_a} D_H$ where $P_a Q_a$ is the rent of before project, $P_s Q_s$ is the rent tenants pay, D_H is defined as $P = \beta Q^{\frac{1}{\alpha}} Y^{\frac{\gamma}{\alpha}}$; α, γ being the price and income elasticity. They suggested the demand curve is of $P = \frac{P_a Q_a}{Q}$, which is a special case. The benefit is equivalent to $P_a Q_a - P_s Q_s + \frac{P_a Q_a^{-1/\alpha}}{(1/\alpha)+1} [Q_s^{(1/\alpha)+1} - Q_a^{(1/\alpha)+1}]$ under the assumption of demand curve is $\beta Q^{1/\alpha} Y^{\gamma/\alpha}$.

Mayo (1986) made a comparison of the U.S. and German experience on the sources of inefficiency in subsidized housing programs. He compared the benefits and costs of a housing program, so if the benefits exceed the costs, then a program will be efficient. He decomposed the sources of inefficiency into two parts, one of which is production inefficiency resulted from resources costs exceed the housing market value. Another one is consumption inefficiency as a result of the housing valued by the recipients that is less than the market value of the housing. He derived a formula

measuring tenant benefits by means of Marshallian consumer's surplus,

$$B = \left(\frac{1}{H_m}\right)^{1/b} \left(\frac{b}{1+b}\right) [H_s^{\frac{1+b}{b}} - H_m^{\frac{1+b}{b}}] + R_m - R_s$$

where H_s is housing services consumed in the subsidized housing program, H_m is before-project housing service consumed, b is price elasticity of demand, R_s is rent paid in the subsidized program, and R_m is rent paid in the absence of the subsidized program. Moreover, he took the ratio of cash equivalent of subsidy to market value of subsidy to obtain consumption efficiency. Participants in housing allowance obtain the highest satisfaction, and in contrast, participants in section 8 new construction programs have the lowest consumption efficiency. Production efficiency is measured as the ratio of resource cost to market rent of subsidized unit. The Wohngeld program¹ has the highest program efficiency whereas the public housing program has the lowest program efficiency.

Sumka and Stegman (1978) derived a more rigorous hedonic rent,

$$R = \alpha \prod_i X_i^{\beta_i} \left(\prod_j e^{\delta_j D_j} \right)$$

which could be used to estimate the explicit prices of individual dwellings for private equivalent rents. They also regressed tenant benefit against household characteristics. The result indicated benefits decreasing with income increasing. They also found a nonlinear relation between tenant benefits and age of head.

Bish (1969) discussed a variety of situations that might be applicable to the public housing program. He applied Prescott's net benefits approach to this study

¹Wohngeld program is a kind of German housing allowances, which make a direct cash payment to tenants in units leased from the existing private stock or provided under the Social Housing program. Participants payment is the difference between lease amounts and subsidy amounts.

(i.e., gross rent minus total tenant payment). First, he assumed that participants had a demand curve with a unitary price elasticity of demand so that their housing outlay would be unchanged. Another case discussed is that the tenants residing in public housing pay less in housing outlay than before project rent. In this case, as long as the price elasticity of demand is equal to unity the direct benefits should be greater than the increase in housing consumption. On the other hand, if the household's housing outlay is unchanged under the subsidy programs, then the direct benefits should be equal to the housing consumption increase (the direct benefits measured by the market rent minus total tenant payment). The last case is that the tenants are likely to pay more rent in public housing than their payment in private housing, in which case tenant benefits should be smaller than the increase in housing consumption due to the deadweight loss.

Struyk (1988) adopted Olsen's approach to estimate net benefits, that is, $NB = P_m Q_m - P_c Q_c + P_m Q_m [\log P_m Q_c - \log P_m Q_m]$. In addition, he employed two methods to estimate the market rent of the program unit. One was to use the present market rent of a similar unit in the neighborhood as the estimate and the other option was to estimate rent from the hedonic model. Income, market rent, family size, and time in unit were arguments in his benefits model.

3.2.2 Hicksian measure

Desalvo (1971) distinguished two cases in estimating the tenant benefits of housing programs. One case is households having the freedom to choose their housing units, and then pay a less-than-market rental on what they choose. Another case is

an all-or-none choice.

In this paper Desalvo employed the Hicksian Equivalent Variation as his theoretical basis.

Schwab (1985) discussed the benefits of in-kind government programs in a different way, beginning with the ordinary demand function, from which he derived the indirect utility function and expenditure function instead of starting from the direct utility function. He also adopted Hicks' compensating variation, which is different from the Hicks' equivalent variation employed by previous studies.

Sa-Aadu (1984) incorporated distortions in the participant's consumption patterns in the section 8 new construction program in which he measured direct benefits in terms of equivalent variation (EV) and compensating variation (CV) approaches.

De Borger (1987a) suggested that Hicks' compensating and equivalent surpluses are particularly suited to make welfare comparisons in quantity-constrained regimes. By comparing empirical results of this paper De Borger concluded that the composite goods approach would overestimate the true benefits obtained using the method by housing characteristics.

3.2.3 Specific utility functions analysis

De Borger (1987b) suggested that housing is a heterogeneous good and the housing service could no longer be treated as a composite good.

The purpose of De Borger's study is to compare the difference between housing service defined as **housing attributes** and housing service distinguished from **all other goods (composite goods)**. An empirical result is that tenant benefits are

overestimated in terms of composite goods. Also the benefits estimated by Cobb-Douglas utility functions are slightly higher than by Stone-Geary utility functions.

Clemmer (1984) concentrated on the discussion of Cobb-Douglas, the CES, the generalized CES, and the Stone-Geary functions. He also analyzed the use of money-income-constant demand functions and real-income-constant demand functions.

The Cobb-Douglas (CD) utility function is of the form $U = KH^aE^{1-a} + C$, where a is equal to the percentage of income spent on housing. H denotes housing service and K stands for the consumption of a composite of all other goods. The constant elasticity of substitution (CES) utility function is of the form $U[aH^b + (1-a)E^b]^{\frac{1}{b}} + C$ with two parameters a, b . The elasticity of substitution is equal to $\frac{1}{1-b}$, if $b=0$ then CES is the same as CD. The Stone-Geary utility function has the form $U = K(H - H_0)^a(E - E_0)^{1-a} + M$, where H_0, E_0 are subsistence consumption levels; it is not restricted on the income and price elasticities. The general CES utility function proposed by Murray is of the form $(aH^b + (1-a)E^c)^d$, in which income elasticity is not restricted to unity. With respect to estimating recipient benefits it does not provide an explicit formula for cash-equivalent income.

Clemmer also showed that EV could be measured by use of real-income-constant (compensated) demand curves. In public housing with quantity constraint, the EV is equal to zero in that the recipient is on the same indifference curve. In the empirical part, Clemmer compared the magnitude of gross subsidy, Consumer's surplus, Cobb-Douglas EV, Stone-Geary EV, Linear demand EV and Nonlinear demand EV. The gross subsidy is equal to predicted market value of subsidized unit minus total tenant payment. The consumer's surplus is measured along a Marshallian demand curve

(a money-income-constant demand curve). The Cobb-Douglas EV is the equivalent variation derived under the assumption of Cobb-Douglas utility. The Stone-Geary utility EV is obtained under the assumption of Stone-Geary utility. The Linear demand EV is measured along compensated linear demand curves and nonlinear demand EV is measured along compensated demand curves nonlinear in income. Stone-Geary EV is more accurate than Cobb-Douglas EV in that the unitary elasticity of price and income is relaxed.

At last he concluded as follows:

The empirical work provides an important comparison of this new approach to those used by previous researchers, and suggests that utility-function-based measures have no obvious advantages over measures based on demand functions. Both require knowledge of the preference structure and information on income, quantities, and prices. Both can yield the theoretically correct measure of in-kind benefits equivalent variation of income. Since demand-function-based measures have the potential for better explanation of variations in quantity consumed in response to variations in price and income, they are preferred to measure based on explicitly direct utility functions.

Reeder (1985) analyzed the benefits and costs of the Section 8 Existing Housing program in which he compared the difference between equal-subsidy cash grants and the Section 8 Existing program. In addition, he examined its allocative and distributive effects. Indifference curve analysis is adopted to measure the tenant benefits. The utility function is represented by $U = [H_K - B_{h,k}]^{a_{h,k}} [X_k - B_{x,k}]^{1-a_{h,k}}$ and the

budget constraint is $Y_k - P_{h,j}H_k - P_{x,j}X_k = 0$. By the process of maximizing utility he obtained the estimate of benefits as $B_k = \left[\frac{P_{h,j}H_{g,k} - P_{h,j}B_{h,k}}{a_{h,k}} \right]^{a_{h,k}} \left[\frac{P_{x,j}X_{g,k} - P_{x,j}B_{x,k}}{1 - a_{h,k}} \right]^{1 - a_{h,k}} + P_{h,j}B_{h,k} + P_{x,j}B_{x,k} - Y_k^0$.

The data were collected from a nationwide random sample of 1,233 families in the Section 8 program in 1976. The empirical results indicate that participants experienced an increase of 11 percent in housing consumption and decrease of 6 percent of other goods consumed than they would have had with the cash grant. He deflated nominal benefits and income by a cost-of-living index and also took into account a nonlinear model that included real income, family size, age. Finally Reeder suggested that the poorest and largest families receive the largest benefits upon this sample collected.

Cronin (1983) focused his discussion of the efficiency of subsidized programs. He divided the type of housing subsidy into a housing gap (income-conditioned) subsidy and a percent-of-rent (price-reduction) subsidy. The former is attributed to the housing voucher and rent certificate programs discussed later in our study. He chose a Stone-Geary utility function since the Stone-Geary utility provided an analytic form (unlike CES) and its price and income elasticity are not tied to unity (unlike the Cobb-Douglas and the CES); that is, it could be applied widely in his paper. The Stone-Geary utility function is employed in the analysis of the distributional impact and efficiency. Both Cobb-Douglas and Stone-Geary utility functions are applied in the comparative analysis of demand-oriented housing programs versus production-oriented housing programs. The empirical results show that the demand-oriented programs are more efficient than are production-oriented programs.

Desalvo (1975) employed the Cobb-Douglas utility function to estimate the benefits and costs of New York City's middle-income housing program. He also derived an estimated form of net tenant benefits as follows : $B_t^n = (\frac{R_m}{\beta})^\beta (\frac{Y - R_p}{1 - \beta})^{1 - \beta} - Y$, where B_t^n is net tenant benefits, R_m is market rent of subsidized unit, Y is household income, and R_p is project rent of subsidized unit. He defined gross tenant benefits equal to the sum of net tenant benefits and project rent, while further assuming that the total benefits are equal to gross tenant benefits plus nontenant benefits. He also defined the sum of tenant contribution (project rent) and subsidy as the total resource cost. Therefore, the minimum nontenant benefits could be measured by the difference between gross tenant benefits and total resource cost. He used an ordinary least squares approach to predict rent-income ratio. With respect to tenant benefits distribution, he adopted a linear regression equation to measure net benefits that were found to have a positive relationship with age of household head and family size and a negative relationship between net benefits and female-headed households.

Murray (1975) first advocated the generalized CES utility function,

$$U = (aH^b + X^c)^d$$

where H and X are quantities of housing services and nonhousing goods, respectively; a , b , and c are parameters of the utility function, and d is an arbitrary scale factor, in which case the utility function allows both income and price elasticities to vary. If the $b = c = 1/d$, the generalized CES utility function converges to an ordinary CES function.

In his paper, he took 86 public housing projects in seven cities in 1968 and estimated the parameters of the Cobb-Douglas, the CES, and the generalized CES.

He tried to test the hypothesis that the true specification is Cobb-Douglas or ordinary CES.

To determine the distribution of benefits, constant dollar benefit was regressed on real income, age and race of head, family composition, and city of residence for both the Cobb-Douglas and generalized CES benefit estimates. The results show a negative sign with income in generalized CES, but a positive sign with the Cobb-Douglas utility function. Nonwhites receive larger benefits than whites and the larger families have larger benefits.

3.2.4 Other related studies

Morrall III and Olsen (1980) discussed the cost-effectiveness of leased public housing, and provided two ways to predict market rents. In addition to hiring appraisers or using an estimated relationship between rent and housing characteristics, collecting information on the rent and characteristics of unsubsidized dwelling units is another alternative.

Total cost consisted of the rent paid by households, the subsidy paid by LHA and utilities expense. The study found little difference in the cost-effectiveness of new, existing, and rehabilitated leased-housing programs.

De Borger (1986) developed three types of demand-oriented programs: a constrained price subsidy, a housing allowance program, and a combination of a price subsidy with cash grants. A constrained price subsidy is related to those who consume housing with a market rent between minimum and maximum levels. Households have a freedom of choice of housing characteristics under the rent constraint. The subsidy

is paid directly to the landlord. The second program in this paper is the housing allowance, that is, a cash grant to participants. The consumers are free to choose their housing units subject to the condition of a minimum rent requirement. The last program is the combination of the two programs above.

As in other papers, De Borger also regressed tenant benefits of the three programs against family characteristics such as income, family size, and age. A nonlinear model was also used with income and family size. The empirical results were good since benefits could be explained well by those independent variables. However, the regression results for public housing did not result in a good relationship between benefits and the independent variables based. The author concluded that Belgian policy makers should consider demand-oriented housing programs instead of the public housing program.

Khadduri and Struyk (1982) advocated the new program in their paper named Housing Vouchers for the poor. In this paper, public housing, Section 236, and EHAP (Experimental Housing Allowance Program) are compared on the basis of 1,975 data from Pittsburgh and Phoenix. Section 236 has the smallest benefits and the highest deadweight loss in both cities. The voucher program cost less than the other programs and was preferred by recipients.

Olsen (1971) proposed housing voucher programs, which might be divided into three cases. Households might be inside program or outside program. Provided that the households enter this program, they will consume exact face values of the certificates or consume more than the face values of the certificates. In this thesis, the data show that the participants in housing voucher program consume more than

face value of the certificates. He stated the following:

Some of the proposed schemes envisage giving recipients vouchers with face values equal to the difference between the amount necessary to purchase the desired quantity of the good on the private market and the amount that the recipient would spend in the absence of a subsidy.

If the consumption of the optimal quantity of housing require the recipients to consume more than the face value of the certificate, the recipients will consume less than the desired quantity of housing service under their assumption of the participants spend exactly the amount of the certificate on housing.

3.3 Summary

Most of Marshallian demand approaches are widely applied under the unitary price elasticity in the theoretical part, and from which some estimates are derived. Recently the Hicksian measure has been widely employed in housing subsidy papers. Especially, the specific utility functions are adopted, complicating this analysis due to the uncertainty of the utility functions.

4. METHODOLOGY AND HYPOTHESES

4.1 Hypotheses

In the traditional housing market¹, housing service is defined as the quality of service yielded by one unit of housing stock per unit of time (Muth, 1960). In other words, we could view housing stock as the input for the provision of housing service. Furthermore, Muth has estimated the price and income elasticities of housing demand to be very close: -1 and +1². De Leeuw (1971) concluded that the income elasticity of housing demand was around 1 for renters, whereas the price elasticities of housing demand appear to have a larger variation³ (Lee, 1968). However, it seems to be acceptable that we assume that the price elasticity of housing demand is unity.

The following hypotheses will be tested in this thesis.

(A) The tenant benefits in the housing vouchers program are greater than in public housing and rent certificates due to the income transfer.

(B) Participants with the same income have a greater benefits in the housing

¹While housing service is of primary concern in this thesis the housing stock is another market in which housing structure is treated as a commodity.

²Some previous studies, nevertheless, have found the price and income elasticities far below unity. For simplicity and convenience we assume, on average, the price and income elasticity equal to unity.

³De Leeuw suggested the range from -0.7 to -1.5 for renter. Tong Hun Lee suggested that the range from -1 to -2 for owners.

voucher program. Thus, benefit-income ratios by income class are highest for voucher tenants.

(C) The more income the households have, the less benefits the household will receive under these housing programs.

In this thesis we follow most of the assumptions from previous studies. First of all we assume two composite goods in this society, one is housing services and the other one is nonhousing goods and services⁴. Second, we assume that housing services are homogeneous goods, not heterogeneous goods; that is, households live in the same quality and space dimension. Thirdly, the long-run supply curves in both markets are perfectly price elastic. Fourth, a single price prevails on the private market; this implies a unique H^* for the three programs. Finally, information and transportation cost will be ignored and both goods are normal goods and the markets for housing and nonhousing goods are perfectly competitive and in long-run equilibrium⁵.

4.2 Methodology

In this chapter we investigate the Marshallian consumer's surplus and Hicks' equivalent variation as estimates of housing benefits⁶. The former could be observable whereas the latter appears to be observable with some technical difficulty. Empirically, the Hicksian measure requires a specific utility function. However, in this

⁴In fact, composite goods result in overestimate net tenant benefits.

⁵Mayo (1981) assumed that the price elasticities of housing demand are between 0 and -1, monopoly with the positive marginal revenue at equilibria, could not be consistent with this assumption.

⁶Hicks (1956) illustrated the comparison of Marshallian measure and Hicks measure; moreover, he indicated the advantage of the Hicks measure.

chapter the Hicksian measure will be discussed in a general form.

Marshallian consumer's surplus, the measurement of the area to the left of the Marshallian demand curve between two prices, has been controversial for years (Willig, 1976), (Hausman, 1981). Despite the drawbacks⁷ economists still widely employ it as a welfare measure since its demand function is observable. Hicks' consumer surplus is being employed recently, but due to its unobserved indifference curve economists must derive some appropriate utility functions for welfare measurement. Although the advent of the approach makes welfare measurement more accurate than before, the utility function forms still have no consensus among economists and cost-benefit analysts.

The purpose of this chapter is just to employ both approaches in the analysis and compare the net direct benefits among the public housing, rent certificates, and housing voucher programs. First we will graphically, in turn, discuss the three programs.

4.2.1 Public housing

We follow the diagram (Olsen and Prescott, 1969) using the Marshallian consumer's surplus approach. As noted above, the housing market is perfectly competitive so that at long-run equilibria each unit of housing service sells for the same price. Graphically, this is shown in Figures 4.1 and 4.2. Figure 4.1 represents the Marshallian approach in which the demand curve has a unitary price elasticity of housing demand (denoted as D). Housing service and a uniform price per unit of housing ser-

⁷One of the drawbacks is that it is not easy to justify **deadweight loss**.

vice are denoted as H and P , respectively. Tenants should pay rent (PH) for specific housing services consumed. In Figure 4.1 assume that an eligible family pays $P_1 H_1$ as before-project rent, whereas, if participating in this program, he is forced to consume the quantity (H^*) and pay $P_3 H^*$ for his project rent (normally, $P_3 H^*$ is smaller than $P_1 H_1$).

With respect to the measurement of net direct benefits three estimates are of interest. First, benefits can be evaluated by the difference between project rent ($P_3 H^*$) and the market rent of public housing unit ($P_1 H^*$). This approach was derived by Prescott and is denoted by BP. This measure is established under the assumption that the demand curve is perfectly price elasticity. That is, subsidy would be a benefit measure.

$$BP = \sum_{i=1}^n [(P_1 H^*)_i - (P_3 H^*)_i] = \sum_{i=1}^n (P_1 H^*)_i - \sum_{i=1}^n (P_3 H^*)_i \quad (4.1)$$

where n represents family size class, H^* is fixed quantity provided by local public housing authority, and $P_1 H^*$ is private equivalent rent. The method is likely to overestimate the net direct benefit since the consumer evaluates units of H along ad not ab. An alternative is derived by Olsen and is denoted by BO⁸.

$$BO = \sum_{i=1}^n (P_1 H_1)_i - \sum_{i=1}^n (P_3 H^*)_i + \left[\sum_{i=1}^n (P_1 H_1)_i \right] \left[\log \sum_{i=1}^n (P_1 H^*)_i - \log \sum_{i=1}^n (P_1 H_1)_i \right]. \quad (4.2)$$

A third measure is the change in income that is attributable to the public housing

⁸In terms of the area left of the Marshallian demand curve, that is, the excess of the consumer's surplus under ($P_3 H^*$) over the consumer's surplus under ($P_1 H_1$). This is

$$\left(\int_0^{H^*} D - P_3 H^* \right) - \left(\int_0^{H_1} D - P_1 H_1 \right) = P_1 H_1 - P_3 H^* + \int_{H_1}^{H^*} D$$

if we substituted $PH = P_1 H_1$ for D , then we can obtain the BO estimator.

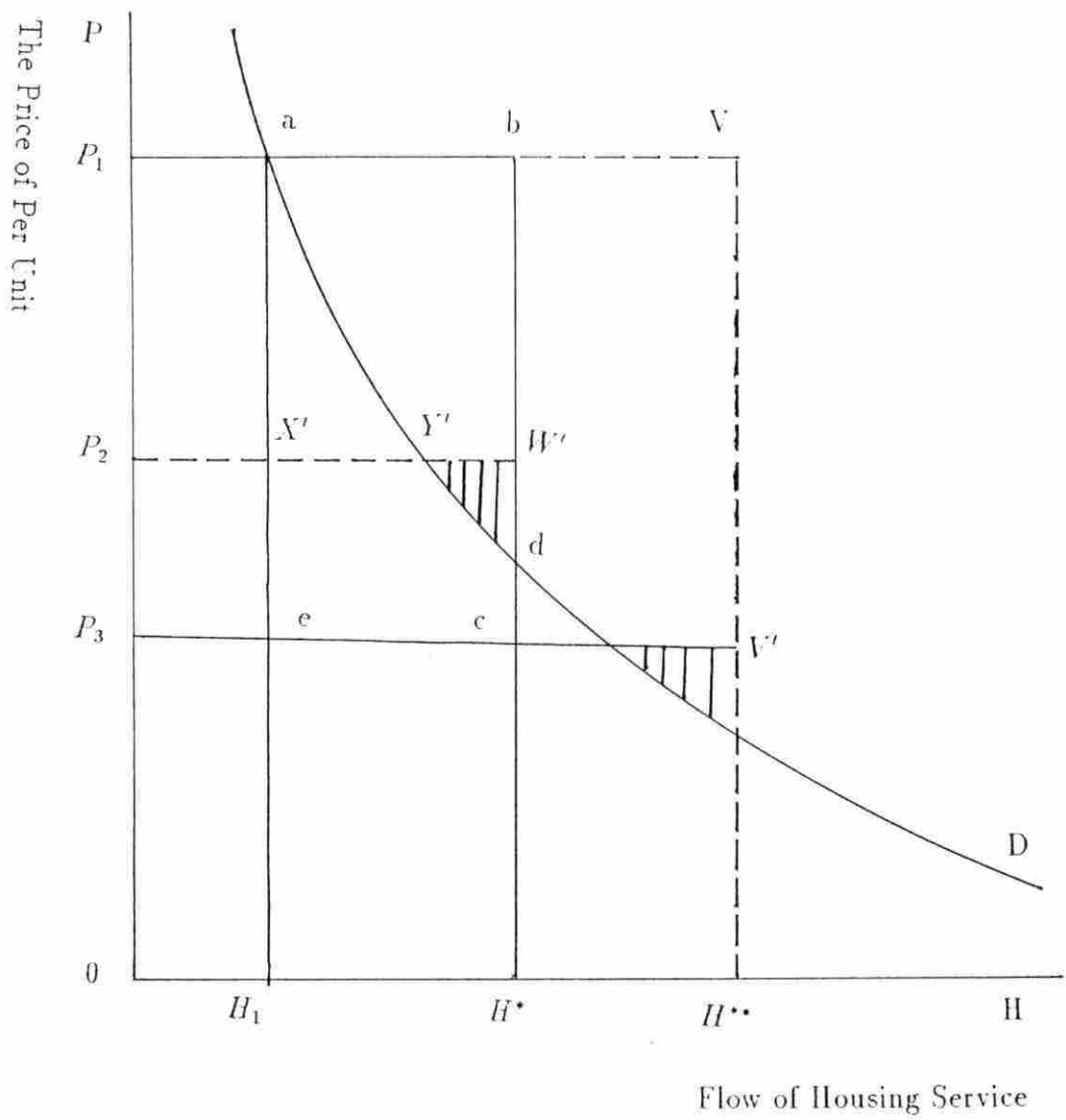


Figure 4.1: Public housing - Marshallian measure

program and this is denoted as

$$BX = \sum_{i=1}^n (P_1 H_1)_i - \sum_{i=1}^n (P_3 H^*)_i \quad (4.3)$$

From Figure 4.1 note that the Prescott measure is equal to the area P_1bcP_3 , and the Olsen measure is equal to the area P_1adceP_3 . Equation 4.3 provides a measure of the increase in nonhousing goods that can be purchased in the program. Clearly, the Prescott measure is larger than Olsen measure. The Marshallian demand curve is derived under the assumption of money income unchanged, and the point c is not on the demand curve since the public housing offer is **take it or leave it** at a fixed quantity; the tenants have no choice among alternative housing units. In other words, they only occupy all of H^* and they cannot consume more or less than this amount.

In the situation discussed above we assumed that the price of per housing service unit is P_3 under participation in this program with H^* as the fixed offer. If the price of per dwelling unit is P_2 while the housing quantity provided is fixed at H^* , the program might have deadweight loss, $Y'W'd$, due to an inappropriate price charged. For $P = P_2$ the tenant would consume less than H^* in private market. If the loss ($Y'W'd$) exceed the $P_1aY'P_2$ the participant would not enter the program. In addition to the above case, the another deadweight loss case might result from a larger quantity offered (as H^{**}) at the P_3 Price. For $P = P_3$ the tenant would privately demand more than H^* .

In contrast, indifference curves are utilized in Figure 4.2 to illustrate the Hicksian approach. As shown in Figure 4.2 the tenant need not maximize his utility under the quantity constraint, H^* , so the ratio of marginal utilities will not necessarily equal relative prices. We also can examine the inefficiency of the in-kind subsidy. As a

participant, he is required to pay KG and the subsidy cost to the government is GE. However, if an unconstrained cash payment is made to tenants in lieu of the all-or-nothing offer, the subsidy cost to government is FE (where FE is less than GE). The in-kind transfer is inefficient relative to unconstrained cash subsidy. The two approaches can be compared in Figures 4.1 and 4.2, in which the YIE budget line corresponds to P_1 , the YG budget line correspond to P_3 , and KG^9 is equal to P_3H^* . GE is the same as the P_1bcP_3 , and KE is equal to P_1bH^*o . Point I is his pre-project position with utility level U^0 . Once the eligible tenant enters the program, the utility increase is to U_2 ($U_2 > U_0$).

Note that the Hicksian measure (denoted by a $Y'F$ budget line) and Slutsky measure (denoted by a $Y''G$ budget line) result in less housing consumption than H^* . If H^* is socially optimal, then the income transfer at I''' with U_3 utility would be inefficient compared to the in-kind transfer.

4.2.2 Rent certificates

The rent certificate program is quite similar to public housing though the process of subsidization is different. As discussed above, public housing offers a fixed housing quantity (including location, style...etc.). On the other hand, the rent certificates establish a monetary standard¹⁰. The participant cannot consume above the standard. The subsidy is based on the difference between the fair market rent and a fraction of income (the higher of 30 percent of the adjusted income or 10 percent of gross income). The Local Housing Agencies (LHAs) send the subsidy checks to landlords

⁹KG is 30 percent of adjusted income as rent.

¹⁰That is, find a fair market rent vary with family size, bedrooms.

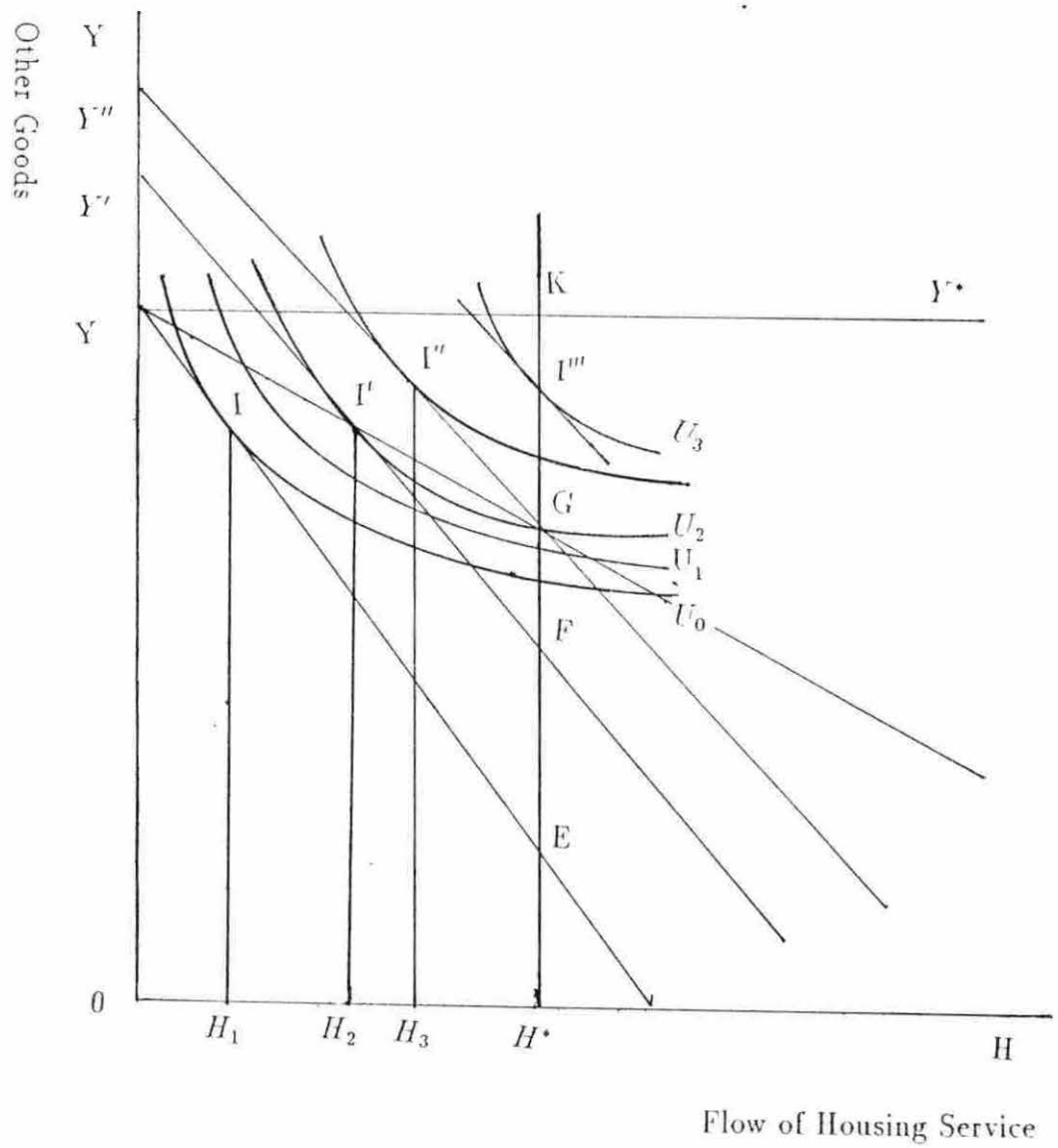


Figure 4.2: Public housing - Hicksian measure

directly. Under this situation, most participants should find housing in which rent is very close to Fair Market Rent. Notice that the households in the rent certificates program have more freedom to choose their housing style and location. The program probably provides greater satisfaction than public housing for the participants. However, the imposition of fair market rent might result in the rent increase in order to reach the monetary standard, and an under-table trade could occur between tenant and landlord. To remedy this possibility the minimum housing standard approach was proposed by the Friedman and Weinberg (1982) and will be discussed further on.

The Marshallian and Hicksian measures are also used to analyze this program. Figures 4.3 and 4.4 are analogous to Figures 4.1 and 4.2. In Figure 4.3 $P_1b'H^*O$ is the fair market rent, and so constitutes an expenditure constraint, not a quantity constraint. Figure 4.4 can be related to the Hicksian measure. Due to the characteristics of this program, as drawn, this household selects the point m^{11} . In addition, point I' represents the bundle consumed in the absence of program with a U_0 utility levels, whereas as a participant the utility increase is from U_0 to U_2 . The participant selects point m instead of G' since U_2 is greater than U_1 .

The two figures can now be compared. The subsidy cost, mL , is equal to $P_1b'c'P_2$, and the benefits nL are about the same as the $P_1a'd'c'P_2$. The ratio of the benefit to subsidy is FE/GE in Figure 4.2 and nL/mL in Figure 4.4. Clearly, the rent certificate is roughly more efficient than the public housing if this ratio is the efficiency measure.

¹¹Usually, the tenants in rent certificates consume a little less than the fair market rent, however, the tenants are not allowed to have a credit. Notice that Reeder (1985) thought the tenants might have obtained a credit, but the rule had been already changed after his paper was published.

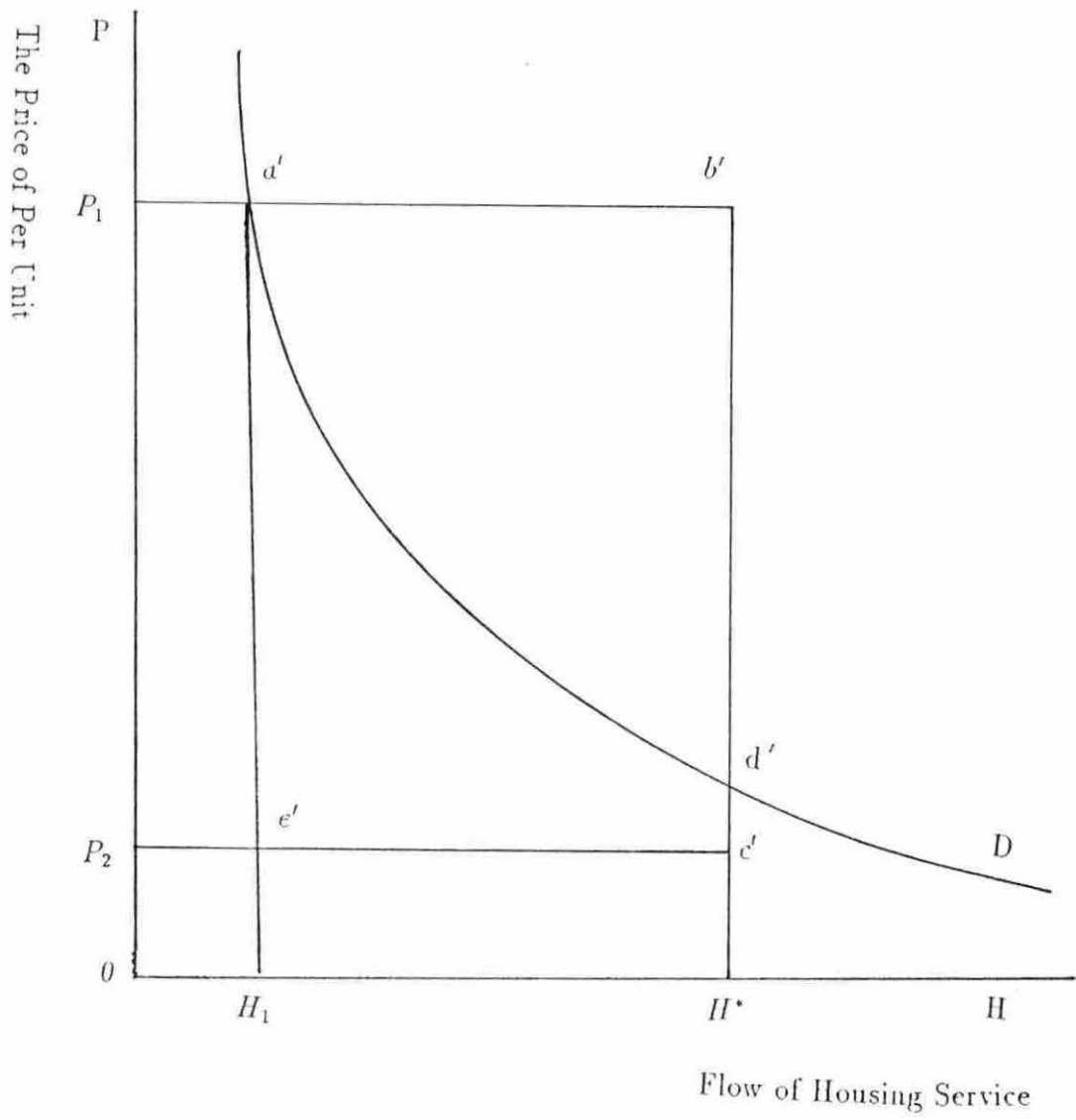


Figure 4.3: Rent certificates - Marshallian measure

4.2.3 Housing voucher program

The voucher program is close to an unconstrained cash subsidy, but it is based on a fixed expenditure standard as with rent certificates. In view of this constraint we call this program **quasi-constrained**¹². The major advantage in this program is that the participant can consume more or less than the payment standard¹³. The subsidy is also based on the difference between the payment standard and the proportion of income¹⁴.

Figures 4.5 and 4.6 show the analysis for vouchers. First, we will distinguish the vouchers from the two other programs. Vouchers participants receive the subsidy and experience an outward shift in their budget constraints due to the real income increase (rent reduction). If they consume more, then they must pay the additional amount by themselves (such as CJ in Figure 4.6) but if they consume less, they are credited with the difference between the standard and rental rent paid (for example, BH in Figure 4.6). If they consume housing service at point c, then the situation is similar to the rent certificates tenant.

Next we analyze the voucher program using Figures 4.5 and 4.6. In Figure 4.6 the point A represents the before program rent with utility U. Due to the effect of increasing income, the budget line shifts upward to a new position defined as $YAA'BH_4$. Since the subsidy is conditional on buying some housing so the budget constraint is jumping from YA' to BH_4 . As a participant, if the household selects

¹²Actually, the voucher program is, in essence, closer to unconstrained cash subsidy than is rent certificates.

¹³Refer to the definition of the Chapter One.

¹⁴The minimum payment is 10 percent of gross income.

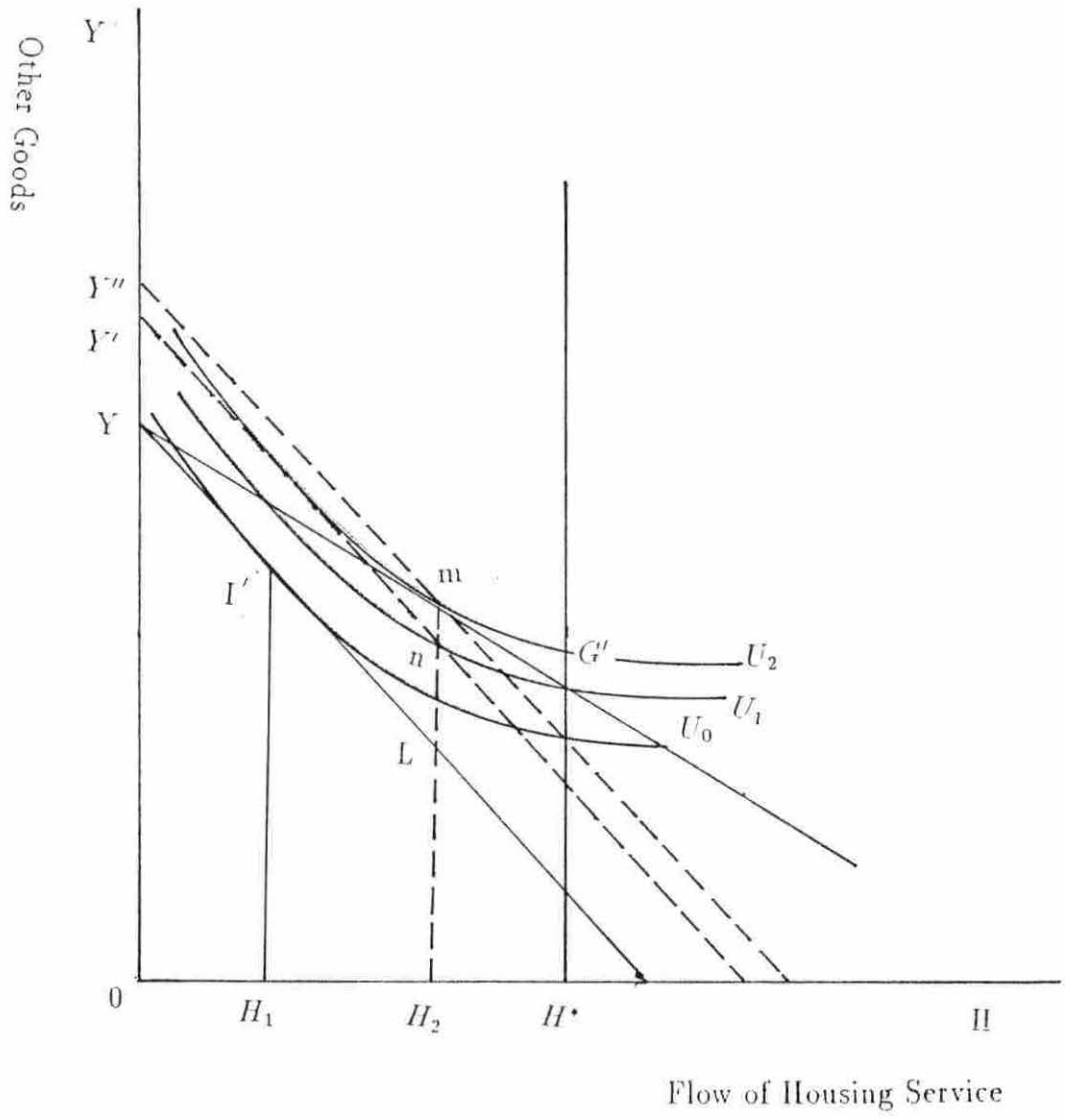


Figure 4.4: Rent certificate - Hicksian Measure

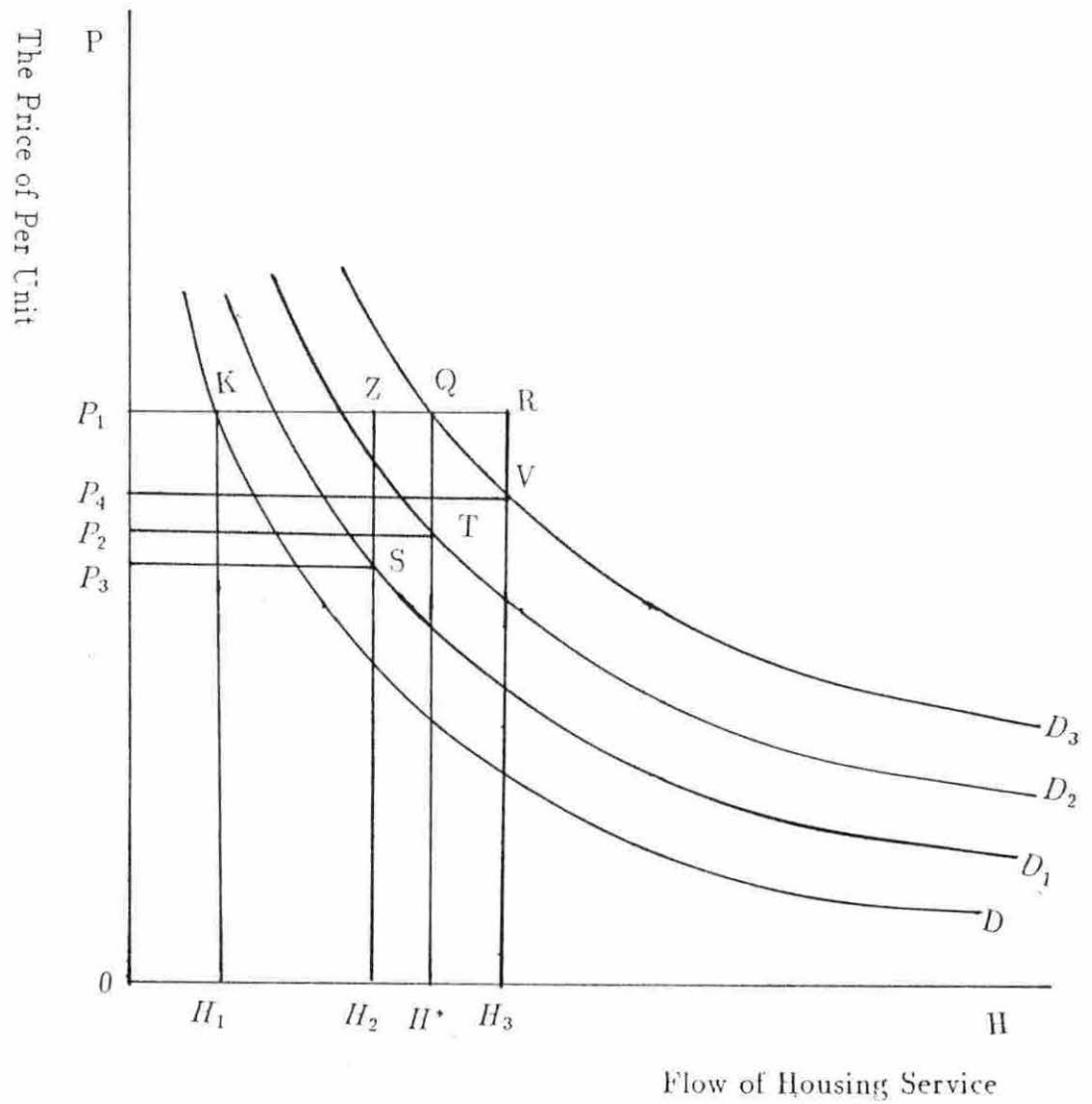


Figure 4.5: Vouchers - Marshallian measure

point B (corresponding to S in Figure 4.5)¹⁵, he uses some of the subsidy to buy other goods and faces a cheaper housing service price relative to point C and D. On the other hand, if he chooses point D (corresponding to V in Figure 4.5)¹⁶, then he prefers housing services to other goods or services, but he would pay for the additional housing from his own pocket. In this program, the household would maximize his utility at point B, or C, or D. Notice that the point S, T, V are on the demand curve instead of below the demand curve as in the two previous programs. The demand curve also shifts from D to D_1, D_2 and D_3 (i.e., increasing housing services demand). From the consumer's viewpoint, it is likely that this program is superior to other programs.

As noted above, the housing vouchers participants could consume more or less housing, and if they consume less, they could obtain a credit (normally, an acceptable unit is found for a rent less than the standard). However, there may be a lower boundary to avoid housing consumption by the imposition of a minimum standard¹⁷. Next, we will discuss this situation by means of indifference curve (Friedman and Weinberg, 1982).

In Figure 4.7 point Z is before the program and Z_1 is the position under the program for tenants. Now, if the minimum standard is imposed at H'_m , the constraint has no effect on the tenant. Although the housing subsidy increases income, the transfer is still kind of different from the unconstrained income transfer, that is,

$$^{15} P_2TH^*O - ZQH^*H_2 = P_3SH_2O = B'B.$$

$$^{16} P_2TH^*O + QRH_3H^* = P_4VH_3O = D'D.$$

¹⁷For convenience, in graph analysis, we adopt the minimum standard instead of minimum rent analysis. In fact, the minimum standard approach is much more costly and imposes inconveniences on tenants and landlords.

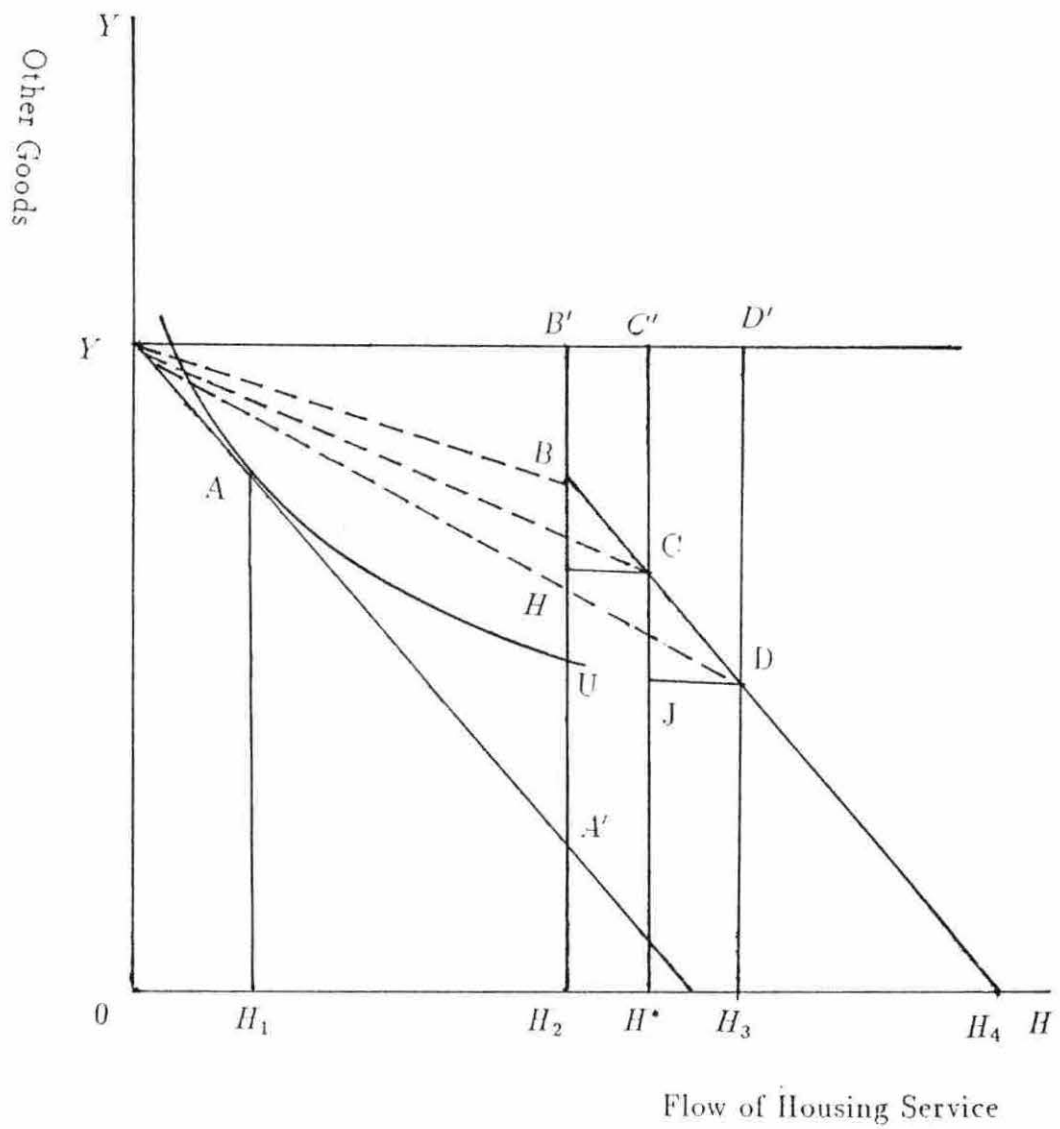


Figure 4.6: Vouchers - Hicksian measure

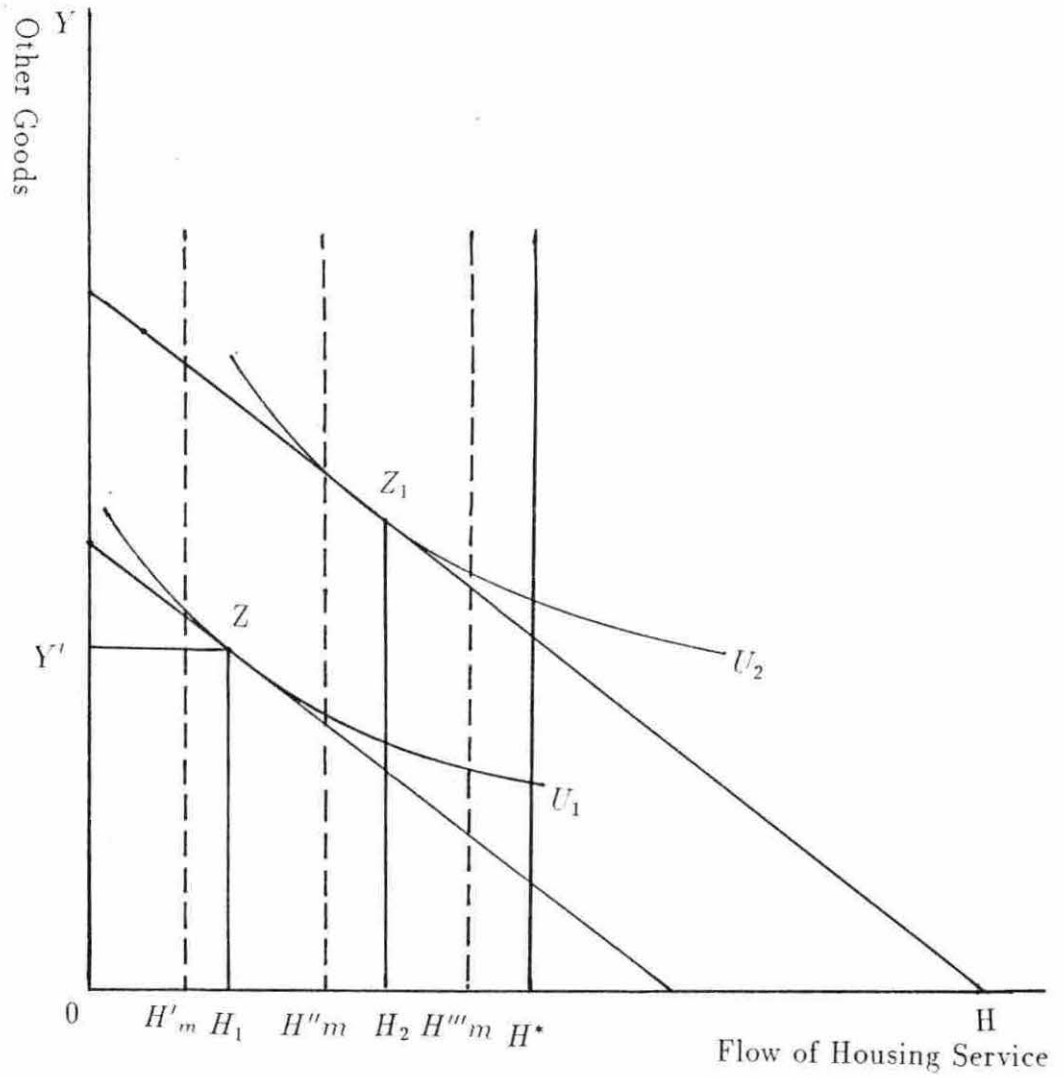


Figure 4.7: Minimum standard analysis

the subsidy formula is actually tied to housing consumption. If the constraint is imposed on point H_m'' , the tenant's decision is still not affected by this constraint since the participant goes from Z to Z_1 ; the tenant consumes more than the constraint. Finally, if the minimum standard is put between H_2 and H^* , H_m''' , it seems to push participants to consume more housing and this case might have resulted in inefficiency due to the limited resource; in other words, if the participants consume more housing, consumption of fewer nonhousing goods will result, in which case resource allocation is inappropriate. As noted before, the drawbacks of rent certificates could be improved by removing the imposition of fair market rent (FMR) and imposing the minimum standard to keep from increasing rent.

4.3 Summary

From economic theory it is difficult to tell which program is best for either participants or taxpayers. However, in our society consumers may prefer the subsidy in the form of an income transfer instead of the in-kind transfer; on the other hand, if there are many paternalistic altruists in our society, it is likely that the in-kind transfer is preferred (Olsen, 1971). In the following chapter the Des Moines samples of tenants for the three programs will be empirically tested to establish differences in net tenant benefits.

5. EMPIRICAL ESTIMATES

5.1 Data Selection and Characteristics

The data collected are on tenant characteristics based on individual files of the Des Moines Housing Authority during the period February–May, 1989. The public housing units are primarily duplexes, with a few high rise apartments housing elderly tenants. All dwelling units in the three programs are dispersed quite evenly around Des Moines. All the necessary data are available in the individual file except the private equivalent rent in the public housing¹. In order to remedy this defect, the Des Moines Housing Authority maintains separate estimates for private equivalent rents by unit size and zones within the city and these are used for the public housing program.

At the beginning of the data collection we had sampled more units than the sample number finally used in this empirical study. In the process of selection, it was suggested that some households with special low before-program rents should be excluded from the final sample².

Table 5.1 illustrates average characteristics of the households with the standard

¹Previous studies took either an expert's opinion or a hedonic estimator.

²Some pre-project rent was reported as zero due to living with parents or relatives, in which case the variance in income at low rent may be very large. Sampled units with less than \$200 in pre-project rent were excluded from the final sample.

Table 5.1: Sample characteristics for housing programs

| Items | Public Housing | Rent Certificates | Vouchers |
|-----------------------|----------------|-------------------|-------------|
| Before-project rent | (N = 45) | (N = 31) | (N = 30) |
| | \$279.73 | \$268.61 | \$283 |
| | (\$61.72) | (\$58.26) | (\$60.20) |
| Annual Income | \$8564.42 | \$6899.54 | \$6318.96 |
| | (\$4190.11) | (\$2200.35) | (\$2613.54) |
| Age of Household Head | 32.57 | 40.00 | 35.20 |
| | (7.77) | (16.63) | (12.56) |
| Family Size | 3.20 | 3.30 | 3.06 |
| | (1.27) | (1.66) | (1.01) |
| Race | 0.77 | 0.64 | 0.70 |
| (White = 1) | (0.42) | (0.48) | (0.46) |
| Sex of Household Head | 0.75 | 0.74 | 0.86 |
| (Female = 1) | (0.43) | (0.44) | (0.34) |

deviations in parentheses. By comparison, the tenants in voucher program lived in the housing with higher rent, and the households in public housing have higher annual income, and a higher standard deviation as well (it is possible that the income limit of the programs result in this outcome when public housing has a more liberal limit than the other two programs). Thus the voucher program help **truly needy** households more than does the other two programs. Other characteristics are very similar among the three programs; the household head in public housing is slightly younger and the family size is about three persons for all three programs. The percentage of white household head ranges from 64 percent (rent certificates) to 77 percent (public housing) and is similarly distributed within each program. Most of household heads are female (ranging from 86 percent to 74 percent). In addition, from the characteristics of the data file, we know that many household members are young, divorced females with children and have income from a public assistance source.

In Table 5.2 the percentage change in housing consumption is calculated as the gross rent divided by before-program rent and the percentage change in nonhousing consumption is obtained by the ratio of the income for nonhousing goods to the before-program rent minus total tenant payment. The price change is estimated the ratio of the gross rent and total tenant payment. Referring back to the figures in Chapter 4 the percentage change in housing consumption is $\frac{P_1bH^*0}{P_1aH_10}$ in Figure 4.1, $\frac{P_1b'H^*0}{P_1a'H_10}$ in Figure 4.3, and $\frac{P_1QH^*0}{P_1KH_10}$ (as consumed at H^*) in Figure 4.5 and the percentage change in nonhousing consumption is the difference between P_1aH_10 and P_3CH^*0 in Figure 4.1, $P_1a'H_10$ minus $P_2C'H^*0$ in Figure 4.3, and P_1KH_10 minus P_2TH^*0 (as consumed at H^*) in Figure 4.5. The price change is $\frac{P_1bH^*0}{P_3CH^*0}$ in Figure 4.1, $\frac{P_1b'H^*0}{P_2C'H^*0}$ in Figure 4.3, and $\frac{P_1QH^*0}{P_2TH^*0}$ (as consumed at H^*) in Figure 4.5.

Table 5.2 shows that households in public housing consume more housing (63%) than in the other two programs and the households in the voucher program have the largest increase in real income (50%) than the other two programs. If the households return to the private market they would incur a price rise factor ranging from 2.9 (rent certificates) to 2.54 (public housing). Public housing tenants have the highest percentage increase in housing consumption due to the second highest pre-project rent and the highest gross rent among the three programs. On the other hand, the vouchers tenants experience more nonhousing consumption (i.e., more real income) probably resulting from the properties of the income-transfer, and due, partly, to having the lowest average income.

Table 5.2: The percentage change in housing and nonhousing goods consumption

| Programs | The Percentage Change in Housing Consumption | The Percentage Change in Nonhousing Consumption | The Price Change |
|-------------------|---|--|---------------------|
| Public Housing | 63% | 23% | 2.54 |
| Rent Certificates | 60% | 39% | 2.9 |
| Voucher Program | 50% | 50% | 2.8 |

5.2 Benefits Estimate

As indicated in Chapter 4, we utilize the Prescott measure (Equation 4.1), the Olsen measure (Equation 4.2), and the real income measure (Equation 4.3). These estimates for the three programs are showed in Table 5.3. Due to the demand curve shifts for the voucher program, we must know the before-program rent change with the demand curve shifts³. Estimated regression equations utilizing the full voucher sample had very low income elasticities, due, perhaps, to ‘charity rents’ attained at very low incomes⁴. The final regression exclude the nine lowest rent observations.

Table 5.3 shows the benefits comparison among the three programs under the sample change from 30 to 21 for the voucher program with the standard deviations shown in parentheses. Pre-project rent regressed against the income and other tenant characteristics can be used to calculate this demand curve shift. The max value is

³For the three programs, the rent-income ratio is 0.39 (public housing), 0.46 (rent certificates), and 0.53 (vouchers), respectively. Before-program rent is used in this ratio.

⁴We did try to use **frontier regression**, in which case the positive residuals in the equation with a intercept resulted in no improvement. In the graph of before-program rent against income, we found nine observations with a wide variation in income at very low rent.

Table 5.3: Benefits comparison

| Methods | Public Housing (N=45) | Rent Certificates (N=31) | Voucher (N=21) |
|---------------------|--------------------------|-----------------------------|--|
| Prescott | \$275.46 (\$101.88) | \$280.58 (\$108.76) | \$280.52 (\$87.46) |
| Olsen | \$227.39 (\$93.74) | \$236.96 (\$94.46) | max : \$268.88 (\$92.82) min : \$265.08 (\$84.05) |
| Real Income Measure | \$100.311 (\$105.01) | \$120.38 (\$94.43) | max : \$298.69 (\$119.23) min : \$185.78 (\$89.107) |

obtained from the following equation:

$$LYY = 0.616 * LY1 + 0.397 * LA + 0.145 * LN - 0.039 * R + 0.433 * S \quad (5.1)$$

where LYY means predicted before program rent in log form; $LY1$ means monthly income plus subsidy in log form; LA means the age of the household head in log form; LN means the family size in log form; R means the race (white = 1); and S means the sex of the households head (female = 1). The min value is obtained from the following equation:

$$YY = 0.077 * Y1 + 2.107 * A + 34.587 * N + 18.325 * R + 79.046 * S \quad (5.2)$$

There are two regressions representing the high-low elasticity range for demand curve shifts in the voucher tenant calculations. The double-log equation's elasticity is 0.616 and the linear equation's elasticity is $(0.077)(525/314)$ or 0.12. where the terms are defined as the above except in arithmetic form with the predicted value being obtained, the values are substituted into the Olsen formula in which the max and

min measures are reported, respectively. In the Olsen measure the difference between the max and min values is not large (about \$3), but in the real income measure the difference between the max and min values is about \$113. Averaged benefits under the three measures are substantially higher in the voucher program.

Notice that in the Prescott measure for cash assistance programs (vouchers and rent certificates) benefits are about \$5 larger than for public housing. Public housing tenants have the highest private-equivalent rent and total tenant payment, and the voucher program has the second highest private-equivalent rent and total tenant payment⁵. By comparison, the private-equivalent rent difference between vouchers and public housing is about \$20, and the total tenant payment difference between vouchers and public housing is about \$25. This accounts for the \$5 difference between these programs.

Assume that the subsidy is equal to the difference between market rent and project rent (Desalvo, 1975). In addition, provided that the total benefits are the sum of the project rent and net benefit in which the net benefit is measured by Marshallian consumer's surplus (Olsen's measure) then the efficiency index is represented as the ratio of the net tenant benefits to the nominal subsidy.

Table 5.4 shows the result that the voucher program is more efficient than the other two programs when either the linear or double-log equations are used. At the same time, the public housing program appears to have the largest cost and the lowest

⁵ Although the tenants in voucher program have the lowest gross income, the tenants' payment are partly determined on adjusted income. In addition, the payments standard in the voucher program is slightly lower than the fair market rent in rent certificates.

Table 5.4: The consumption efficiency among the three programs

| Programs | Net Tenants Benefits (1) | Nominal Subsidy (2) | Consumption Efficiency (1/2 * 100) |
|-------------------|--------------------------------|------------------------|---------------------------------------|
| Public Housing | \$227.39 | \$275.46 | 82.54 |
| Rent Certificates | \$236.96 | \$280.58 | 84.45 |
| Vouchers | max: \$268.88 min: \$265.08 | \$280.52 | max: 95.58 min: 94.49 |

Table 5.5: The ratio of benefits to monthly income among the three programs

| Income Range | Public Housing | Rent Certificates | Vouchers Programs |
|--------------|----------------|----------------------|------------------------|
| < 4000 | 0.79 | 0.63 | max: 0.79 min: 0.73 |
| 4000 - 6000 | 0.72 | 0.33 | max: 0.77 min: 0.74 |
| 6000 - 8000 | 0.49 | 0.21 | max: 0.44 min: 0.43 |
| > 8000 | 0.14 | 0.09 | max: 0.18 min: 0.21 |

efficiency among the three programs⁶.

The distribution of benefits among income classes for the three can also be analyzed. Tables 5.5 and 5.6 show that the ratio of benefits to monthly income is decreasing as income increases (except for vouchers' minimum estimate), while the dollar benefits show rising estimates in the second range (\$4,000-6,000) for the voucher and public housing programs. Vertical equity implies declining benefits with rising income so our programs are consistent with this characteristic.

⁶Assume that the total cost is the sum of the total tenant payment and nominal subsidy so the cost incurred to public housing is \$454.88, the voucher program is \$434.66, and the rent certificates is \$428.72.

Table 5.6: Average benefits distribution among the three programs

| Income Range | Public Housing | Rent Certificates | Vouchers Programs |
|--------------|----------------|----------------------|--------------------------------|
| < 4000 | \$266.01 | \$210.49 | max: \$256.24 min: \$238.52 |
| 4000 - 6000 | \$305.34 | \$143.36 | max: \$327.11 min: \$313.29 |
| 6000 - 8000 | \$283.03 | \$122.55 | max: \$255.39 min: \$250.44 |
| > 8000 | \$144.27 | \$80.59 | max: \$164.01 min: \$197.79 |

5.3 The Distribution of the Tenant Benefits

The purpose of this section is to indicate how benefits are affected by household income and other characteristics. OLS regression models are employed as a framework to present these results (alternative models such as the quadratic model and double-log model are shown in the Appendix (Chapter 9)).

$$B = 230.28 - 0.28 * Y + 0.31 * BR - 0.30 * A + 31.26 * N + 4.29 * R + 18.67 * S \quad (5.3)$$

$$R^2 = 0.87; \overline{R^2} = 0.85; F = 44.02$$

t values are 5.58, -15.08, 3.58, -0.40, 5.98, 0.30, 1.39, respectively.

$$B = 232.24 - 0.32 * Y + 0.51 * BR - 0.60 * A + 22.87 * N - 9.44 * R + 22.28 * S \quad (5.4)$$

$$R^2 = 0.84; \overline{R^2} = 0.80; F = 22.25$$

t values are 3.08, -7.38, 3.71, -1.02, 3.28, -0.45, 1.19, respectively.

$$B_{min} = 10.008 - 0.18 * Y + 0.22 * BR + 0.92 * A + 46.53 * N + 6.11 * R + 107.96 * S \quad (5.5)$$

$$R^2 = 0.69; \overline{R^2} = 0.55; F = 5.21$$

t values are 0.09, -2.78, 0.59, 0.88, 2.92, 0.21, 2.62, respectively.

$$B_{max} = 80.38 - 0.28 * Y + 0.31 * BR - 0.19 * A + 53.93 * N + 12.41 * R + 69.13 * S \quad (5.6)$$

$$R^2 = 0.77; \overline{R^2} = 0.68; F = 8.22$$

t values are 0.79, -4.46, 0.89, -0.19, 3.63, 0.46, 1.80, respectively.

Where B , B_{min} , B_{max} are benefits measured by Olsen measure (equation 4.1), Y is monthly income, BR is before program rent, A is age of household head, N is family size, R is race, and S is sex of the family household head.

Equations 5.3, 5.4, 5.5, 5.6 show the linear regression equations in the public housing, rent certificates, minimum vouchers, and maximum vouchers programs, respectively. R^2 is rather large in the three programs, so benefits could be explained well by the family characteristics. There are strong negative relations with the benefits and monthly income for the three programs; at the same time, correct signs and statistically significant t-values result in the importance of income in the four benefits equations. The age of household head and race variables have mixed signs with very low t-values in the four equations. In addition, the tenants living in higher pre-project housing rent should have higher benefits in the program. The elderly have larger benefits in the vouchers program in the minimum voucher equation, whereas young families have larger benefits in the rent certificates, public housing and vouchers program in the maximum equation. White tenants obtain more benefits in the public housing and vouchers programs whereas minorities obtain more benefits in rent certificates. Larger families with the female household heads obtain greater benefits in all three programs.

Several characteristics of the coefficients should be noted. First, note that tenants

in public housing and in the maximum voucher program have the same coefficient on income; that is, an increase in 1 dollar of income leads to the same benefit loss. Rent certificate participants suffer more benefits loss as income increases, whereas the tenants in the minimum vouchers equation experience the smallest benefits loss. Second, the benefits decline for each extra year of age in the three programs except for the linear voucher model. Benefits increase by \$0.92 for each extra year of age in the vouchers program with the minimum equation. For all the equations, the family size is highly significant for the benefits, and the tenants in the voucher program with the maximum equation obtain the largest benefits increase for each extra member of the family. Finally, the white tenants obtain more benefits in the maximum equation, and the female household heads experience the largest benefits increase in the minimum voucher model, although both race and sex coefficients are insignificant.

Finally we exclude the before program rent, age, race, and sex variable due to their low statistical significance. The results are as follows:

$$B = 322.29 - 0.27 * Y + 31.95 * N \quad (5.7)$$

$$R^2 = 0.82; \overline{R^2} = 0.81; F = 99.29$$

t values are 18.56, -14.06, 5.92, respectively.

$$B = 351.74 - 0.37 * Y + 33.04 * N \quad (5.8)$$

$$R^2 = 0.73; \overline{R^2} = 0.71; F = 38.36$$

t values are 10.72, -7.33, 5.88, respectively.

$$B = 220.83 - 0.22 * Y + 50.17 * N \quad (5.9)$$

$$R^2 = 0.49; \overline{R^2} = 0.43; F = 8.77$$

t values are 4.33, -3.50, 3.33, respectively.

$$B = 228.33 - 0.30 * Y + 61.69 * N \quad (5.10)$$

$$R^2 = 0.67; \overline{R^2} = 0.64; F = 19.03$$

t values are 5.09, -5.36, 4.66, respectively.

Where B, Y, N are defined as above. Equation 5.7, 5.8, 5.9, 5.10 refers to the public housing, rent certificates, minimum vouchers, maximum vouchers, respectively. Except for the income coefficient in public housing, the other coefficients on income and family size increase. There is a consistent sign pattern on the coefficients for income and family size with the exclusion of the other variables. All three programs provide greater benefits as income declines and family size increases.

6. CONCLUSION AND FURTHER RESEARCH

6.1 Conclusion

In this thesis, public housing, rent certificates, and the vouchers program are compared on the basis of tenant benefits. Generally, public housing is characterized as a supply-oriented housing program; in contrast, the rent certificates and vouchers programs are demand-oriented.

Tenants in public housing face a reduced price for a fixed-housing offer relative to the other two programs; that is, the program is a kind of price-reduction program in which participants are induced to consume a fixed amount of additional housing services. On the other hand, the rent certificates and vouchers program participants receive cash assistance; that is, the two programs are a kind of income-transfer program. Nevertheless, the two programs are not identical to the unconstrained income-transfer because their subsidies are tied to housing consumption.

The participants are subject to a standard requirement in the cash assistance programs. However, the vouchers program is closer to the unconstrained income-transfer than the rent certificates because the participants in the voucher program can consume more or less; moreover, they can have the rebate if they consume less whereas they must pay additional money from their own pocket if they consume more

housing than the payment standard. The rent certificates participants do not have this option. They also are subject to a monetary standard, unlike a fixed quantity offered in public housing.

Marshallian and Hicksian measures are employed to analyze the net tenant benefits of the three programs in this thesis. The Marshallian measure is for an observable demand curve whereas the Hicksian measure is of the unobservable utility function. Empirically, the Marshallian measure is preferred to the Hicksian measure due to the observable demand curve.

The sample data show that most of the participants have low-incomes, and are headed by young, single, and white females; few minority tenants are found in these programs. The rent-income ratio is quite high for the three programs, but the income elasticities are low; this could result from low income tenants having already met a high minimum standard for housing before they go in the programs, but with a low response for added housing as income rises. Another possibility is observation error¹. From the truncated voucher sample we took max and min estimates applied to the regression model for the vouchers program. Table 5.3 shows that the voucher program participants have the highest benefits whereas the tenants in public housing have the lowest benefits by the Olsen measure. Vouchers program participants have larger increases in real income; the vouchers program seems more efficient than the other two programs.

The benefits regression results are very satisfactory in that benefits correlate

¹It might be due to the use of current income observed instead of permanent income. It is expected that the current income elasticity is less than the permanent income elasticity. The other possibility is that the observations on rent of very low income tenants do not truly reflect private market rents.

well with the explanatory variables. The regression model shows that income has a significant inverse relationship with benefits and before program rent has significance positive relationship with the benefits in the public housing and rent certificates, but an insignificant positive relationship with the benefits in the voucher program. The age and race variables have mixed signs among the three programs, and the larger family and female household head experience more benefits.

6.2 Further Research

Throughout the thesis the comparison of benefits among the three programs has been our purpose; however, some unanswered questions remain. We list as follows:

(A) The income elasticity is quite low for this study. Muth has estimated the price and income elasticities of housing demand to be very close to -1 and +1. However, some previous papers indicated that the price and income elasticities are below unity. A very low income elasticity, relative to the slightly high rent-income ratio, was found in this thesis; it might result from the special low income tenants in our survey. In addition, the program price elasticities are measured by -0.54 (public housing), -0.43 (voucher) and -0.46 (rent certificates); however, the elasticities are not measured along a given demand curve since the fixed offer in public housing and rent certificates and more than one demand curves are involved in the voucher program.

(B) Estimates have been made of the percentage change in H and the income elasticities of demand. An extension would be to calculate unconstrained income subsidies in the three programs that would be necessary to induce tenants to voluntarily purchase H^* . These could then be compared to the actual subsidies provided.

(C) For voucher tenants the distinction between consumption levels below and above H^* should be known from the data. If most tenants consume more than H^* then H^* is on average less than what tenants would prefer given the existing subsidy levels. An averaged total tenant payment for voucher tenants would come close to the privately preferred optimal consumption of H . The ultimate question, of course, is what the socially optimal H^* is, but this is not estimable from the data in our samples.

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9. APPENDIX: REGRESSION EQUATIONS

9.1 Introduction

In this appendix we, in turn, list vouchers, rent certificates, and public housing programs by quadratic and double-log forms. The following equations show the benefits comparison among the three programs utilizing the quadratic and double-log forms. The truncated voucher sample is adopted (N=21) due to the quite low income elasticities. The max and min equations are from the double-log and linear equations, respectively.

9.2 Equations

Vouchers Program Quadratic Equation:

$$B_{max} = 44.06 - 0.02*Y - 0.0001*Y^2 + 0.26*BR - 0.41*A + 51.90*N + 12.43*R + 59.13*S$$

$$R^2 = 0.79; \overline{R^2} = 0.67; F = 7.03$$

t values are 0.40, -0.08, -0.86, 0.72, -0.40, 3.42, 0.46, 1.46, respectively.

$$B_{min} = -46.17 + 0.20*Y - 0.0002*Y^2 + 0.14*BR + 0.58*A + 43.38*N + 6.13*R + 92.50*S$$

$$R^2 = 0.72; \overline{R^2} = 0.57; F = 4.92$$

t values are -0.40, 0.66, -1.29, 0.38, 0.54, 2.76, 0.21, 2.20, respectively.

Vouchers Program Double-Log Equation:

$$B_{lmax} = 16.25 - 2.26 * LY - 0.001 * BR + 0.01 * A + 0.33 * N - 0.03 * R + 2.07 * S$$

$$R^2 = 0.54; \overline{R^2} = 0.34; F = 2.74$$

t values are 2.89, -2.24, -0.13, 0.60, 0.89, -0.05, 2.19, respectively.

$$B_{lmin} = 11.01 - 1.29 * LY - 0.0005 * BR + 0.01 * A + 0.23 * N - 0.06 * R + 1.51 * S$$

$$R^2 = 0.54; \overline{R^2} = 0.34; F = 2.75$$

t values are 3.08, -2.01, -0.09, 0.88, 0.98, -0.14, 2.51, respectively.

Rent Certificates Quadratic Equation:

$$B_{rq} = 187.31 - 0.16 * Y - 0.0001 * Y^2 + 0.49 * BR - 0.60 * A + 23.20 * N - 7.47 * R + 20.24 * S$$

$$R^2 = 0.84; \overline{R^2} = 0.80; F = 18.54$$

t values are 1.63, -0.51, -0.52, 3.47, -1.02, 3.27, -0.34, 1.08, respectively.

Rent Certificates Double-Log Equation:

$$B_{rl} = 12.00 - 1.21 * LY + 0.003 * BR - 0.004 * A + 0.04 * N - 0.13 * R + 0.28 * S$$

$$R^2 = 0.71; \overline{R^2} = 0.63; F = 9.87$$

t values are 7.06, -5.16, 2.84, -0.85, 0.68, -0.73, 1.75, respectively.

Public Housing Quadratic Equation:

$$B_{pq} = 263.49 - 0.40 * Y + 0.00006 * Y^2 + 0.32 * BR - 0.04 * A + 31.04 * N + 9.77 * R + 18.41 * S$$

$$R^2 = 0.88; \overline{R^2} = 0.86; F = 41.40$$

t values are 6.13, -6.45, 2.02, 3.77, -0.06, 6.18, 0.71, 1.43,

Public Housing Double-Log Equation:

$$B_{pl} = 13.12 - 1.36 * LY + 0.002 * BR - 0.002 * A + 0.12 * N + 0.002 * R - 0.02 * S$$

$$R^2 = 0.62; \overline{R^2} = 0.57; F = 10.72$$

t values are 11.73, -7.17, 1.96, -0.23, 1.90, 0.01, -0.16, respectively.